Enclosure design for 3D Printing: A step-by-step gui

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Learn how to optimize the design of your enclosure for 3D printing, follow a step by step guide on the design process and review the most common enclosure materials.

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Introduction

3D printing of enclosures allows design freedom, lets a designer print a prototype or final part in a matter of hours and is much cheaper when compared to traditional manufacturing methods. 3D printed enclosures offer an effective method of confirming form and fit and several of the materials that can be used for printing enclosures are suitable for end use applications.

Assembled 3D printed enclosure for a DIY loudspeaker

This article will discuss the most common 3D printing technologies that are used to print enclosures, methods for securing printed enclosures together and introduce some design considerations to help optimize enclosure design for 3D printing.

3D printed enclosure technologies

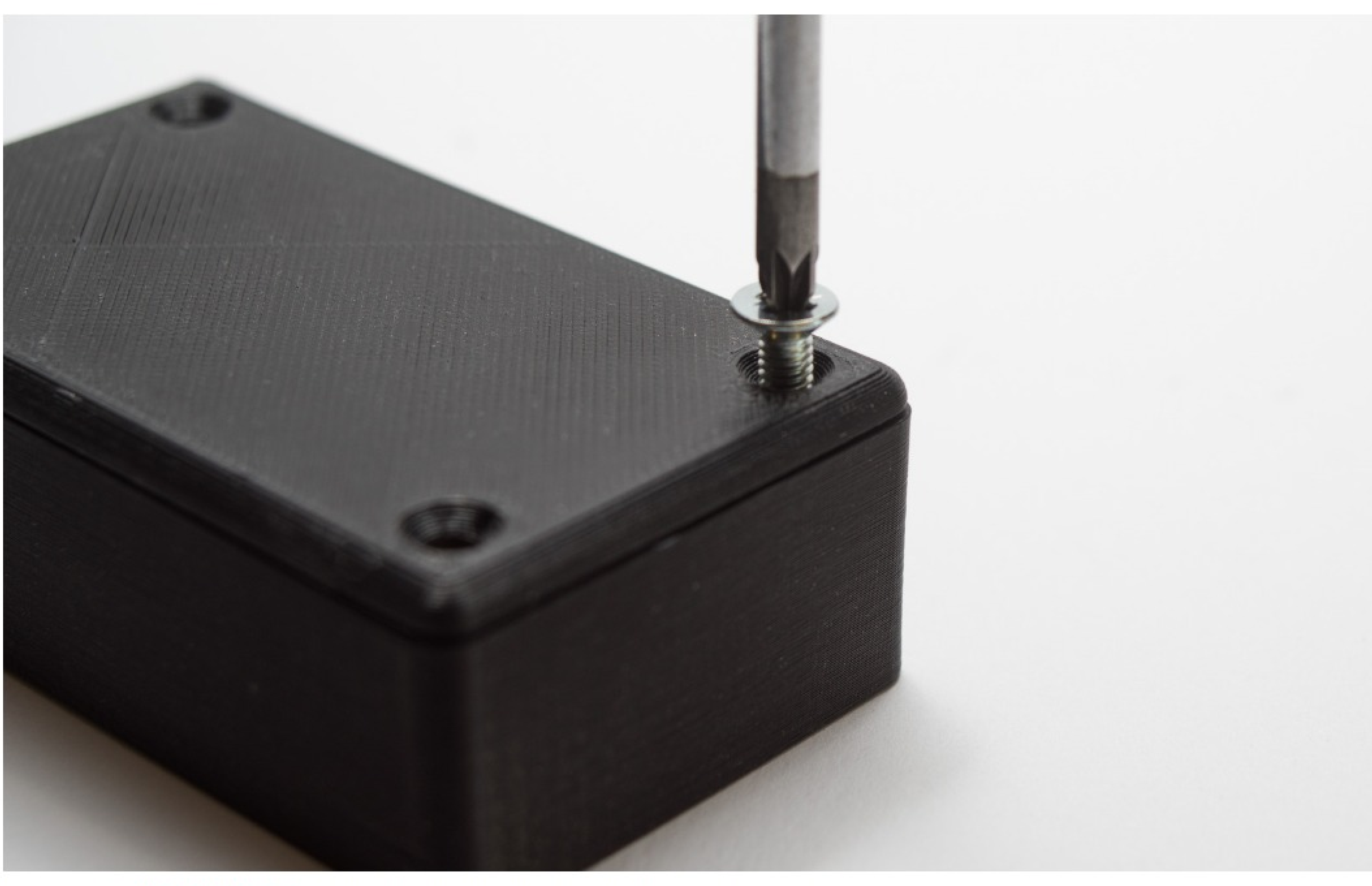
The table below discuss the main 3D printing technologies and whether they are appropriate for a range of enclosure applications.

Application	Description	Printing Technology
Rapid prototyping	Prototyping plastics are a cost effective and quick method of printing enclosures.	FDM
High Temperature	Heat resistant plastics are rated to remain stable up to temperatures as high as 80℃ after thermal post treatment.	Material jetting
High quality surface finish	The selection of surface finish is usually governed by cost and time. SLS nylon results in a satin-like matte finish that is slightly grainy to the touch while material jetting and SLA offer fine-detail models with very smooth surfaces.	SLA or material jetting
High accuracy	SLS nylon, SLA and material jetting printed parts are highly accurate and are capable of printing to within 0.2 - 0.5 mm. They give an excellent surface finish. SLS nylon does no require any support while the support used for material jetting is typically dissolvable and easy to remove resulting in an smooth surface after post processing.	SLA, SLS or material jetting
Transparent	3D printed transparent plastics allow for inspection or verification of internal components and are often applied to applications where fluids are being employed.	SLA or material jetting
Flexible material	Flexible enclosures allow the pressing of buttons or motion of switches through the sealed case.	Rubber-Like plastics or SLA flexible resin

Securing enclosure assemblies

Snap fits, interlocking joints, threaded fasteners and adhesives are all viable options for 3D printed enclosure connections. Designing snap-fits and push-fits for an enclosure that does not require repeated opening is much easier because the joint does not have to be as wear-resistant. For quick prototypes adhesives are a quick and easy method to permanently fasten the enclosure.

Snap-fits are regularly used for securing 3D printed enclosures



Fastening with threaded fasteners is a durable and quick option for reliable repeated opening

Designing 3D printed enclosures

The design of enclosures for 3D printing typically follows 2 main steps:

1. Enclosure planning and component measurement

It can be useful to 3D model the internal enclosure components along with the enclosure to allow for easy clearance checks and to help determine the optimal component positions.

2. Designing the structure

While tolerance and clearance recommendations will vary with printer technology and calibration the bullet points below offer a set of design guideline to use:

- A minimum **wall thickness of 2 mm**.
- Reduce stress concentrations by including **radii or fillets in corner and edges**. Even a small radius can make a big difference.
- Allow **0.5 mm around internal components** to compensate for distortion, shrinkage and printer tolerances.
- Add **0.25 mm to the diameter of screw and fastener clearance holes.**
- Subtract **0.25 mm from the diameter of holes if you are wanting the screw or fastener to bite into the case.**
- Allow **2 mm clearance around ports** (1mm each side).
- If your enclosure design is eventually going to be injection molded remember to use **uniform wall thickness** in you design.
- Add lugs and cut outs to assist with assembly/disassembly and alignment if the enclosure with multiple parts (base & lid).
- While ribs and gussets are critical design features of injection molding and not essential for 3D printing their inclusion can help reduce and distribute stresses throughout the part and improve rigidity. To save on material ribs and gussets can be designed to **75-80% of wall thickness**.
- Include bosses around holes in locations where threaded fasteners will be used to reduce the likelihood of bulging, distortion and potential fracture. A **minimum of 5mm wall thickness** around the hole is a good starting point.

Rules of thumb

- For enclosures that will experience repeated opening and closing a wear-resistant material such as sls nylon. For rapid prototypes where form or fit are being tested FDM provides a fast low cost method of production.
- If the enclosure will be subjected to loads include gussets, ribs and bosses to improve strength
- A minimum wall thickness of 2mm, 0.5mm tolerance around internal components and ±0.25mm for clearance/bite holes are good start points to consider when designing a 3D printed enclosure.

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